CLAIMS

1. Projection objective of a microlithographic projection exposure apparatus (110) for imaging a mask (124) that is disposable in an objective plane (122) of the projection objective (120; 120'; 120") on a photosensitive layer (126) that is disposable in an image plane (128) of the projection objective, wherein the projection objective (120; 120'; 120") is designed for immersion operation in which an immersion liquid adjoins the photosensitive layer (126), and wherein the refractive index of the immersion liquid is greater than the refractive index of a medium (L5; 142; L205; LL7; LL8; LL9) that adjoins the immersion liquid on the object side,
characterized in that

the projection objective (120; 120'; 120") is designed in such a way that the immersion liquid (134) is convexly curved towards the object plane (122) during immersion operation.

2. Projection objective according to claim 1, characterized in that the immersion liquid (134) directly adjoins, during immersion operation, a concavely curved image-side surface (136) of an optical element (L5; L205; LL7; LL8; LL9) that is the last optical element of the projection objective (120) on the image side.

3. Projection objective according to claim 2, characterized in that the curved image-side surface (136) is surrounded by a drainage barrier (140).

4. Projection objective according to claim 3, characterized in that the drainage barrier is designed as a ring (140) that is joined to the optical element (L5) and/or to a housing (141) of the projection objective (120').

5. Projection objective according to any one of claims 2 to 4, characterized in that the curved image-side surface (136) is spherical.

6. Projection objective according to claim 5, characterized in that the curved image-side surface (136) has a radius of curvature (R) that is between 0.9 times and 1.5 times and preferably 1.3 times the axial distance (d) between the curved image-side surface (136) and the image plane (128).

7. Projection objective according to claim 1, characterized in that an intermediate liquid (142), which is not miscible with the immersion liquid (134) and which forms a curved interface (139, 139') in an electric field, is situated during immersion operation between the immersion liquid (134) and an optical element (L5") that is the last optical element of the projection objective (120") on the image side.

8. Projection objective according to claim 7, characterized in that the intermediate liquid (142) is electrically conductive and the immersion liquid (134) is electrically insulating.

9. Projection objective according to claim 7 or 8, characterized in that the intermediate liquid (142) has substantially the same density as the immersion liquid (134).

10. Projection objective according to claim 9, characterized in that the immersion liquid (134) is an oil and the intermediate liquid (142) is water.

11. Projection objective according to any one of claims 7 to 10, characterized by an electrode (146) for generating the electric field.

12. Projection objective according to claim 11, characterized in that the electrode is an annular conical electrode (146) that is disposed between the optical element (L5") and the image plane (128).

13. Projection objective according to claim 11 or 12, characterized in that the curvature of the interface (139, 139') can be altered by altering a voltage applied to the electrode (146).

14. Projection objective according to any one of claims 7 to 13, characterized in that the interface (139, 139') between the intermediate liquid (142) and the immersion liquid (139) is at least approximately spherical.

15. Projection objective according to any of the preceding claims, characterized in that the immersion liquid forms an interface with the medium that is convexly curved towards the object plane in such a way that light rays pass the interface with a maximum angle of incidence whose sine is between 0.5 and 0.98.

16. Projection objective according to claim 15, characterized in that the sine of the maximum angle of incidence is between 0.85 and 0.95.

17. Projection objective according to claim 16, characterized in that the sine of the maximum angle of incidence is between 0.87 and 0.94.

18. Projection objective according to any of the preceding claims, characterized in that within any arbitrary volume within the projection objective the condition $(k^2 + l^2)/n^2 > K_0$ holds, wherein k, l, m are the three direction cosines of an aperture ray, n is the refractive index within the volume with $k^2 + l^2 + m^2 = n^2$ and $K_0 = 0.95$.

19. Projection objective according to claim 18, characterized in that $K_0 = 0.85$.

20. Projection objective according to claim 2, characterized in that the maximum curvature of the image-side surface has a radius of curvature equals the product m·s, wherein s is the axial distance between the curved image-side surface and the image plane and m is a real number between 20 and 120.

21. Projection objective according to claim 20, characterized in that m is between 40 and 100.

22. Projection objective according to claim 21, characterized in that m is between 70 and 90.

23. Projection objective of a microlithographic projection exposure apparatus for imaging a mask on a photosensitive layer that is disposable in an image plane of the projection objective, wherein the projection objective (120; 120'; 120") is designed for immersion operation in which an immersion liquid adjoins the photosensitive layer (126),

characterized in that

the immersion liquid (134) forms an interface with a medium (LL9) that adjoins the immersion liquid on the object side of the projection objective, said interface be-

ing convexly curved towards the mask such that the maximum radius of curvature equals the product m·s, wherein s is the axial distance between the interface and the image plane and m is a real number between 20 and 120.

24. Projection objective according to claim 23, characterized in that m is between 40 and 100.

25. Projection objective according to claim 24, characterized in that m is between 70 and 90.

26. Projection objective according to any one of the preceding claims, characterized in that the projection objective (120) is a catadioptric objective that has at least two imaging mirrors (S1, S2) and in which at least two intermediate images are formed.

27. Microlithographic projection exposure apparatus for producing microstructured components, characterized by a projection objective (120; 120'; 120") according to any one of the preceding claims.

28. Method of microlithographically producing microstructured components, comprising the following steps:

a) providing a substrate (130) to which a layer (126) of a photosensitive material is at least partially applied;

b) providing a mask (124) that contains structures to be imaged;

c) providing a projection exposure apparatus comprising a projection objective (120; 120'; 120") according to any one of claims 1 to 21;

d) projecting at least a part of the mask (124) on a region of the layer (126) with the aid of the projection exposure apparatus.

23. Microstructured component that has been produced by a method according to claim 22.